

California Pest Rating Proposal for
'*Candidatus Phytoplasma phoenicium*' Verdin et al., 2003
Almond witches'-broom phytoplasma

Current Pest Rating: None

Proposed Pest Rating: A

Domain: Bacteria, Phylum: Firmicutes,
Class: Mollicutes, Order: Acholeplasmatales,
Family: Acholeplasmataceae, Genus: Phytoplasma

Comment Period: 01/05/2022 through 02/19/2022

Initiating Event:

The USDA's Federal Interagency Committee on Invasive Terrestrial Animals and Pathogens (ITAP.gov) Subcommittee on Plant Pathogens has identified the worst plant pathogens of greatest concern that are either in the United States and have potential for further spread or represent a new threat if introduced. '*Candidatus Phytoplasma phoenicium*' is on their list. A pest risk assessment of this species complex is presented here, and a permanent pest rating for California is proposed.

History & Status:

Background: In 1999, almond trees with symptoms of leaf yellowing, shoot proliferation, and dieback were observed in Lebanon. A phytoplasma belonging to taxonomic group 16SrIX-B, the pigeon pea witches' broom cluster, was identified and reported, and given the name '*Candidatus Phytoplasma phoenicium*' (Verdin et al., 2003).

Phytoplasmas are phloem-limited pleomorphic bacteria lacking a cell wall, mainly transmitted by leafhoppers, and are also moved with plant propagative materials. They cause yellowing symptoms by clogging phloem tissue sieve tubes and interfering with transportation of photosynthate out of the leaves. They can also produce biologically active toxic substances, causing death of the leaves, inflorescences, and vegetative buds of their hosts. Witches' brooms can be a symptom of phytoplasma infection; they are a dense mass of shoots growing from a single point, with the resulting structure resembling a broom or a bird's nest. Species descriptions of bacteria belonging to the class Mollicutes typically require an accompanying culture of the organism. However, because phytoplasmas are very

difficult to isolate in culture and maintain in vitro, lineages within this group are generally referred to as '*Candidatus Phytoplasma species*' (Davis and Sinclair, 1998).

In addition to almond, '*Ca. P. phoenicium*' is also associated with a severe disease of peach and nectarine. After its initial detection, it was found to be widespread throughout Lebanon, from coastal to high mountainous areas. In Iran, the disease was first detected in almond (Salehi et al., 2006) and later in apricot (Salehi et al., 2018). Recently, almonds with phytoplasma symptoms associated with '*Ca. Phytoplasma phoenicium*' have been reported in Southern Italy (Nigro et al., 2020). The rapid spread of the disease with a combination of infected planting stock and flying vectors is a great concern to stone fruit growing countries worldwide.

Almonds are the 2nd most valuable commodity in California after milk and cream with an estimated value in 2019 of over \$6B. Almonds are also California's number one agricultural export (\$4.9B of the \$6B). California produces all of the almonds grown in the United States. They are mainly grown in the Central Valley; the counties with the most production are Fresno, Kern, Stanislas, Merced, San Joaquin, Kings and Madera. Adding the value of apricots (\$40M), peaches (\$300M), and nectarines (\$130M) shows the size of the California stone fruit industry that is potentially vulnerable to this phytoplasma (CDFA Agricultural Statistics, 2020).

Hosts: The natural host range of '*Ca. P. phoenicium*' is mostly restricted to cultivated almond (*Prunus dulcis*, *syn=P. amygdalus*) and wild almond (*P. orientalis*) but has also been identified in association with a severe disease of peach (*P. persica*), nectarine (*P. persica* var. *nucipersica*), and apricot (*P. armeniaca*). Other hosts are chamomile (*Anthemis spp.*), wild almond (*P. scoparia*), and common smilax (*Smilax aspera*) (Quaglino, 2017; EPPO datasheet 2021).

Symptoms: Expression of symptoms depends on many factors including initial inoculum level, incubation period, tree age, tree species and cultivar, and general health status of the tree. Trees generally suffer from a reduction of leaf size and yellowing of leaves, stunted growth with short internodes, off-season growth, leaf rosetting, early flowering, with decline and die-back (Salehi et al., 2006).

On almond, symptoms manifest as the proliferation of slender shoots at multiple points on the main trunk, or from the roots, with an occasional development of a witches' broom, but only on some trees. On peach and nectarine, the first symptom is early flowering (15 to 20 days earlier than normal), followed by the early development of the buds from infected branches. Later, phyllody and serrate, slim, light green leaves develop on branches. Proliferation of shoots, and witches' brooms can develop from the trunks and crowns of affected trees (Molino Lova et al., 2011; Salehi et al., 2019). On *Prunus amygdalus xpersica*, characteristic symptoms of the disease have been observed as internode shortening, chlorosis, reduced size of leaves (especially in the witches' broom), proliferation of slender upright shoots, witches' broom, stunting, and dieback (Salehi et al., 2011). On *Prunus scoparia*, '*Ca. P. phoenicium*' caused severe witches' broom, yellowing and decline (Salehi et al., 2015). On apricot, leaf yellowing, smaller leaves and inward leaf curl, scorch of leaf margins, shortened internodes, rosette at the tips of branches, die back, and plant death were observed. Affected branches either bore no fruits or produced fruits that were small and abnormal in shape and taste (Salehi et al., 2018).

In the first year after infection, only some branches show symptoms, whereas in the second year, the entire canopy will be affected. Trees decline rapidly and some die within 3-4 years, but others may survive longer. Symptoms appeared exacerbated when trees are heavily pruned. Symptomatic branches or trees produce few or no fruits, and in dry weather, the leaves may appear brownish red (EPPO, 2021).

Transmission: Phytoplasmas are mainly transmitted by sap-sucking insects, mainly Hemiptera, suborders Auchenorrhyncha (families Cicadellidae and Cixiidae) and Sternorrhyncha (Psyllidae). In Lebanon, the leafhopper *Asymmetrasca decedens* transmits almond to almond, and in the cixiids, *Cixius* sp., *Tachycixius* spp., and *Eumecurus* spp., transmit from weeds to almonds (Abou-Jawdah et al., 2014). None of these species are known to be in California (CDFA PDR database).

Other than flying vectors, the main pathway for entry to new areas and spread over short and long distances is the movement of infected host plant material as rooted or unrooted cuttings, tissue culture, scions, and rootstocks. No transmission through pollen, seeds, or fruits has been demonstrated. Because the disease was identified in both Lebanon and Iran in the same time period, it is likely that dissemination of infected planting material. Other possible pathways are movement of cut branches and fresh almonds with shells (Quaglino, 2017).

Damage Potential: ‘*Candidatus P. phoenicium*’ is an economically important and destructive disease, established mainly in Lebanon and Iran where it has killed hundreds of thousands of almonds, peach, and nectarine trees, 3-4 years after the appearance of initial symptoms. Fruit quality is affected, and yield reduction can reach 70 to 100 %, depending on the proportion of infected canopy (Verdin et al., 2003; Salehi et al., 2006, 2011, and 2018). It has spread rapidly in Lebanon and Iran, has accidentally been introduced into Italy, and may be present but unconfirmed in additional European and Asian countries.

Worldwide Distribution: Iran, Italy, and Lebanon. (CABI-CPC, 2021)

Official Control: ‘*Candidatus P. phoenicium*’ is on the EPPO’s A1 list for the European Plant Protection Organization, and is a quarantine pest for Morocco (EPPO, 2021).

California Distribution: None

California Interceptions: None

The risk ‘*Candidatus Phytoplasma phoenicium*’ would pose to California is evaluated below.

Consequences of Introduction:

- 1) Climate/Host Interaction:** ‘*Ca. P. phoenicium*’ is found in the phloem tissue of the stems and the roots of host plants throughout the year. It is likely to be found anywhere its hosts can be grown.
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Evaluate if the pest would have suitable hosts and climate to establish in California.

Score: 3

- Low (1) Not likely to establish in California; or likely to establish in very limited areas.
- Medium (2) may be able to establish in a larger but limited part of California.
- **High (3) likely to establish a widespread distribution in California.**

- 2) Known Pest Host Range:** The known host range is *Prunus* spp. (almond, apricot, and peach), *Anthemis*, and *Smilax*.

Evaluate the host range of the pest.

Score: 2

- Low (1) has a very limited host range.
- **Medium (2) has a moderate host range.**
- High (3) has a wide host range.

- 3) Pest Reproductive Potential:** Reproduction is limited to the phloem of infected hosts. Flying insect from diverse taxonomic groups have been identified as vectors in some areas. California may already have competent vectors for this phytoplasma.

Evaluate the natural and artificial dispersal potential of the pest.

Score: 3

- Low (1) does not have high reproductive or dispersal potential.
- Medium (2) has either high reproductive or dispersal potential.
- **High (3) has both high reproduction and dispersal potential.**

- 4) Economic Impact:** '*Ca. P. phoenicium*' has a high likelihood of establishing, spreading, and causing damage, especially where vectors occur. Damage to stone fruits crops caused by '*Ca. P. phoenicium*' can include the complete loss of fruits and the death of trees. Quarantine restrictions for imports of potentially infected planting materials are essential.

Evaluate the economic impact of the pest to California using the criteria below.

Economic Impact: A, B, C, D, E

- A. The pest could lower crop yield.**
- B. The pest could lower crop value (includes increasing crop production costs).**
- C. The pest could trigger the loss of markets (includes quarantines).**
- D. The pest could negatively change normal cultural practices.**
- E. The pest can vector, or is vectored, by another pestiferous organism.**
- F. The organism is injurious or poisonous to agriculturally important animals.
- G. The organism can interfere with the delivery or supply of water for agricultural uses.

Economic Impact Score: 3

- Low (1) causes 0 or 1 of these impacts.
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- Medium (2) causes 2 of these impacts.
- **High (3) causes 3 or more of these impacts.**

5) **Environmental Impact:** There are many native *Prunus* spp. in California and their susceptibility to this phytoplasma is unknown. Any detections would likely trigger state and federal action to eradicate the disease through a combination of tree removal and vector control.

Evaluate the environmental impact of the pest to California using the criteria below

Environmental Impact: A, D

- A. The pest could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes.**
- B. The pest could directly affect threatened or endangered species.
- C. The pest could impact threatened or endangered species by disrupting critical habitats.
- D. The pest could trigger additional official or private treatment programs.**
- E. The pest significantly impacts cultural practices, home/urban gardening or ornamental plantings.

Environmental Impact Score: 3

- Low (1) causes none of the above to occur.
- Medium (2) causes one of the above to occur.
- **High (3) causes two or more of the above to occur.**

Consequences of Introduction to California for '*Candidatus Phytoplasma phoenicium*': High

Add up the total score and include it here. **14**

- Low = 5-8 points
- Medium = 9-12 points
- High = 13-15 points**

6) **Post Entry Distribution and Survey Information:** Evaluate the known distribution in California. Only official records identified by a taxonomic expert and supported by voucher specimens deposited in natural history collections should be considered. Pest incursions that have been eradicated, are under eradication, or have been delimited with no further detections should not be included.

Evaluation is 'not established'.

Score: 0

- Not established (0) Pest never detected in California or known only from incursions.**
 - Low (-1) Pest has a localized distribution in California or is established in one suitable climate/host area (region).
 - Medium (-2) Pest is widespread in California but not fully established in the endangered area, or pest established in two contiguous suitable climate/host areas.
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-High (-3) Pest has fully established in the endangered area, or pest is reported in more than two contiguous or non-contiguous suitable climate/host areas.

7) The final score is the consequences of introduction score minus the post entry distribution and survey information score: (Score)

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information = 14*

Uncertainty:

Generally, '*Ca. P. phoenicium*' is symptomatic in infected trees, but it can have a relatively long incubation period. Phytoplasmas may be unevenly distributed in the plant which creates challenges for sampling. There may be insects already present in California that will be able to act as vectors if the phytoplasma is introduced.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for '*Ca. Phytoplasma phoenicium*' is A.

References:

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Responsible Party:

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***Comment Period: 01/05/2022 through 02/19/2022**

*NOTE:

You must be registered and logged in to post a comment. If you have registered and have not received the registration confirmation, please contact us at [permits\[@\]cdfa.ca.gov](mailto:permits[@]cdfa.ca.gov).

Comment Format:

- ❖ Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

Example Comment:

Consequences of Introduction: 1. Climate/Host Interaction: [Your comment that relates to "Climate/Host Interaction" here.]

- ❖ Posted comments will not be able to be viewed immediately.
- ❖ Comments may not be posted if they:

Contain inappropriate language which is not germane to the pest rating proposal;

Contains defamatory, false, inaccurate, abusive, obscene, pornographic, sexually oriented, threatening, racially offensive, discriminatory or illegal material;

Violates agency regulations prohibiting sexual harassment or other forms of discrimination;

Violates agency regulations prohibiting workplace violence, including threats.

- ❖ Comments may be edited prior to posting to ensure they are entirely germane.
- ❖ Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.

Proposed Pest Rating: A
